(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 298 934**
A1

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 88850031.1

(22) Date of filing: 27.01.88

(51) Int. Cl.4: **H 05 B 37/02**
H 05 B 41/392

(30) Priority: 09.07.87 JP 169850/87

(43) Date of publication of application:
11.01.89 Bulletin 89/02

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI NL SE

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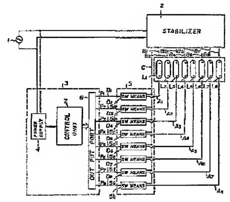
(54) **Lighting apparatus.**

(57) A lighting apparatus for lighting a plurality of discharge tubes such as fluorescent lights or neon tubes, comprising a stabilizer having a plurality of output terminals, one end of each being connected to one end of one of the discharge tubes, a plurality of switching means connecting the other ends of the output terminals of the stabilizer to respective other ends of the discharge tubes individually, and control means for individually and sequentially switching said plurality of switching means, whereby a single stabilizer may be used to turn on a plurality of discharge tubes.

FIG. 1



EP 0 298 934 A1

Bundesdruckerei Berlin

Description

LIGHTING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a lighting apparatus which lights fluorescent discharge tubes, and more particularly refers to a lighting apparatus which lights a plurality of fluorescent discharge tubes with only a single unit of stabilizer in the desired brightness or pattern arrangement.

Description of the Prior Art

In general, it is necessary for lighting the fluorescent discharge tubes to prepare a lighting apparatus having the function to apply a voltage higher than the continuous discharge voltage of fluorescent discharge tubes across both electrodes thereof at the time of starting the discharge and to limit the current flowing into the fluorescent discharge tubes after the tube lights, and also to stabilize an input current for variation of the power supply voltage, because the fluorescent discharge tubes have the characteristic that the tube does not start the discharge unless a voltage several times the continuous discharge voltage is applied at the time of starting discharge, and having such negative characteristic that the terminal voltage becomes near to a constant value even when a supply voltage is increased at the time of continuous discharge period.

The lighting apparatus currently used widely often uses directly a commercial power supply voltage, and the lighting system of the apparatus includes the method of lighting the fluorescent discharge tubes by a glow lamp and a choke coil in case the current capacity is small, or the method of lighting momentarily the fluorescent discharge tubes by the effect of a specially designed coil which is wound to the stabilizer in case the current capacity is intermediate or more. Recently, it has become conventional to employ the method of using an electronic circuit which lights the fluorescent discharge tubes with a high frequency voltage output therefrom.

However, as explained previously, a lighting system (strictly a stabilizer) has always been required for each tube in any lighting system of the prior art. For example, in case many fluorescent discharge tubes must be provided in such a narrow area as a showcase, the lighting apparatus must also be provided in a number equal to the number of fluorescent discharge tubes. In this case, considerable space is required for providing the lighting apparatus, and such apparatus becomes heavy. Moreover, provision of so many fluorescent discharge tubes in such narrow space will make the wiring difficult and require many man hours of installation labor.

In addition, the lighting apparatus of the prior art has been intended in principal to continuously and stably light a single fluorescent discharge tube. Consequently, no lighting apparatus having the function to intermittently light many fluorescent discharge tubes in accordance with the desired pattern like a neon sign with only one lighting apparatus has yet been proposed.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a small size and lightweight discharge circuit which assures wide application range so that a plurality of fluorescent discharge tubes may be lit with only one stabilizer and the lighting pattern can be changed freely.

The foregoing and other objects, advantages, and characterizing features of the invention will become apparent from the following description of certain illustrative embodiments thereof, considered together with the accompanying drawings, wherein like reference numerals signify like elements throughout the various figures.

In order to attain the above-mentioned objects, the present invention comprises a stabilizer of which one end of output terminals is connected to the respective one end of a plurality of discharge tubes, a plurality of switching means which connect the other end of output terminals of said stabilizer to respective other ends of said discharge tubes individually, and a control means which individually switches a plurality of switching means.

The present invention constituted as mentioned above operates as explained hereunder.

When a signal is output from a control means in order to sequentially operate a plurality of switching means, the switching means which has received this signal operates as follows: a voltage supplied from the stabilizer is applied to the fluorescent discharge tubes connected to the switching means and the relevant fluorescent discharge tubes light sequentially.

Accordingly, a small size and lightweight lighting apparatus can be realized by lighting a plurality of fluorescent discharge tubes only with one stabilizer in combination of operation of the switching means and, moreover, it beomes possible to light many fluorescent discharge tubes like a neon sign by previously setting the lighting pattern with the control means.

Brief Description of the Drawings

FIG. 1 is a general circuit outline of structure of the lighting apparatus of the present invention.

FIG. 2 is a more detailed circuit structure of the lighting apparatus of the present invention.

FIG. 3 is an operation flowchart of the lighting apparatus indicated in FIG. 2.

FIG. 4 and FIG. 5 indicate examples of the pulse waveforms output from the control means

of lighting apparatus of the present invention.

FIGs. 6(A) to (C) indicate examples of waveforms output to each point of the lighting apparatus of the present invention.

FIGs. 7(A) to (D) indicate examples of the circuit forming the switching means of lighting apparatus of the present invention, and

FIG. 8 shows another embodiment of the lighting apparatus of the present invention, in which :

1 --- AC power supply; 2 --- electronic stabilizer; 3 --- microcomputer (control means); 3' --- pulse generating circuit (control means); 5 --- switch (switching means).

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, an AC power supply 1 is connected with a stabilizer 2 and a power supply 4 comprised in a microcomputer 3 operating as the control means. Therefore, the stabilizer 2 is always in the operating condition so long as it is connected with the AC power supply 1. The common line C of the stabilizer 2 is respectively connected to the one end of switches 5a to 5h as the switching means, while the load lines B1 to B8 of the stabilizer 2 are connected with the load lines A1 to A8 connected to the other ends of switches 5a to 5h through the fluorescent discharge tubes L1 to L8.

The input terminals of these switches 5a to 5h are respectively connected with the output terminals P1 to P8 of the output port 6 of the microcomputer 3 through the signal lines D1 to D8. This output port 6 is connected with the control unit 7 which operates the switches 5.

For instance, when a pulse is output from the switch 5a from the control unit 7 through the output port 6, since the switch 5a connects with a common line C of the stabilizer 2 and a load line A1, a voltage output from the stabilizer 2 is applied to the fluorescent discharge tube L1, and the discharge tube L1 lights only during the period in which such pulse is applied.

Referring to FIG. 2, a practical circuit diagram of the lighting apparatus shown in FIG. 1 is further illustrated:

The stabilizer 2 shown in this figure is a so-called electronic stabilizer which is formed by an electronic circuit to generate a high voltage. This electronic stabilizer 2 can be roughly classified into the power supply circuit and oscillation circuit.

The power supply circuit is formed by a filter comprising a capacitor 10, a capacitor 11, a coil 12, and a coil 13, a full-wave rectifying circuit 14 and a smoothing capacitor 15, and outputs a predetermined DC voltage to the oscillation circuit.

The oscillation circuit is formed by a resonance circuit comprising an oscillation capacitor 16 and an oscillation coil 17, an oscillation transistor 18 which causes such resonance circuit to generate a voltage of predetermined frequency, a feedback circuit comprising a feedback voltage rejecting diode 19, a feedback signal coil 20, a feedback signal supply capacitor 21, a self-bias resistor 22, a constant voltage diode 23, a feedback signal supply coupling capacitor 24, a feedback voltage rejecting diode 25, a base current adjusting resistors 26 and 27, a base voltage supply resistor 28, etc., and a protection circuit comprising a thermosensitive lead switch 29 which opens the path by detecting heat generated on the self-bias resistor 22 and a semiconductor element 30 which rejects over-voltage applied on the oscillation transistor 18. When this oscillation circuit is connected to the AC power supply 1, a voltage with frequency of about 40 kHz is output.

Next, the microcomputer 3 which operates as the control means is formed by a power supply 4 which receives a voltage from the AC power supply 1 and outputs the DC voltages, for example, of 5V and 12V, a memory 8 which stores the predetermined program or data, an output port 6 connected to respective switches 5a to 5h operating as the switching means explained later and a central processing unit (CPU) 9 which outputs pulses to the predetermined output terminals of output port 6 in accordance with a program. This central processing unit 9 outputs the pulses having the predetermined duty ratio from the predetermined output terminals (P1 to P8) of output port 6, based on the programs and data stored in the memory 8.

The switches 5a to 5h respectively are provided with the same structure (therefore, the structure of only one switch is indicated in Fig. 2). The switch 5a is electrically insulated from the part which intermittently controls a current flowing into the microcomputer 3 and fluorescent discharge tube L1 by a photocoupler 32, the photocoupler 32 is connected to the output terminal P1 of output port 5 by the signal line D1 through a resistor 31 connected in series and the output side of this photocoupler 32 is in the conductive condition while the pulse is output from this output terminal P1. The diode 33 connected to the photocoupler 32 and resistor 31 has the function to protect the photocoupler 32 from over-voltage. The output side of photocoupler 32 is connected to the power supply 4 through a resistor 34 and the transistor 37 and transistor 38 which make the switching operation are connected to the resistors 35 and 36. A full-wave rectifying circuit 39 is connected between the collector and emitter of such transistor 38 and the common line C and the load line A1 connected to the fluorescent discharge tube L1 are also connected to such full-wave rectifying circuit 39.

The structures for the switches 5b to 5h are also the same and respective photocouplers are connected to the output terminals P2 to P8 of ouput port 6 by the signal lines D2 to D8.

Operations of lighting apparatus of the present invention are explained hereunder with reference to Fig. 2, on the basis of the flowchart of Fig. 3.

When the switch 40 shown in Fig. 2 turns ON, first, electrical power is supplied to the oscillation transistor 18 and resonance circuit explained above and the electronic stabilizer 2 starts operations and a high frequency voltage is applied respectively to the one end of fluorescent discharge tubes L1 to L8 through the capacitors 41a to 41h. These capacitors 41a to 41h are provided to reject the DC element to

be supplied to the fluorescent discharge tubes. Simultaneously, the microcomputer 3 starts operations (step 1), the central processing unit 9 reads the lighting pattern (data for lighting sequence of fluorescent discharge tubes L1 to L8 and duty ratio of pulse output from the output port 6) stored in the memory 8, calculates to output the pulse having what duty ratio to any terminal among the output terminals P1 to P8 of output port 6 (step 2), outputs the result of such calculation to the ouput port 6 and outputs the pulse having determined duty ratio to the selected output terminal. For instance, if it is supposed that such pulse is output from the output terminal P1 of output port 6, this pulse flows into the photocoupler 32 through the signal line D1, thereby the output terminal of photocoupler 32 becomes conductive only when the pulse is set to the HI condition. Under this condition, the transistor 37 turns ON and the transistor 38 also turns ON. Thereby an output voltage of electronic stabilizer 2 is applied to the fluorescent discharge tube L1 through the full-wave rectifier 39 and load lines A1, B1 in order to light such discharge tube L1. Therefore, the fluorescent discharge tube L1 lights only in the HI condition of pulse (step 3). The central processing unit 9 waits for the predetermined period after outputting this pulse (step 4), reads another lighting pattern stored in the memory 8 like the processing in the step 2 and calculates again to output the pulse having that duty ratio to any terminal among the output terminals P1 to P8 of the output port 6 (step 5). Above operations are repeated until the switch 40 is turned OFF (step 6).

The lighting apparatus of the present invention is explained in more detail with reference to the waveform diagrams of Figs. 4 to 6.

When the pulses having the waveforms shown in Fig. 4 are output from the output terminals P1 to P8 of output port 6 of the microcomputer 3, the switches 5a, 5b, 5c, 5d, 5e, 5f, 5g and 5h make the switching sequentially. Thereby, the fluorescent discharge tubes L1 to L8 sequentially light in every period of T' indicated in Fig. 3. In the microscopic viewpoint, the fluorescent discharge tubes light one by one but the duration of pulse output from the output port 6 is very momentary (for example, the ON period is 1 ms, OFF period is 5 ms, in this case, the duty ratio is 1/6). Therefore, a person sees eight tubes as if these were lit simultaneously. Moreover, since a high frequency voltage of about 40 kHz is output from the electronic stabilizer 2, there is no fear of generating any discrepancy such as flickering, etc.

In addition, referring to Fig. 5, when the duty ratio of pulses output from the output port 6 is set large, the lighting period of fluorescent discharge tubes naturally becomes long, since two tubes light simultaneously in some periods. Accordingly, the luminosity is increased from that in case the waveforms indicated in Fig. 4 are applied to the switches. Namely, in case the duty ratio of pulses output from the output port 6 is changed, luminosity can be changed freely in proportion to such duty ratio. However, if such duty ratio becomes too large, it is possible that the electronic stabilizer 2 generates an overload. Therefore, it is desirable that the duty ratio is set within the range which does not result in overload of electronic stabilizer 2. Moreover, when a program, which realizes simultaneous ouptut of pulses having the same duty ratio at a plurality of output terminals, is stored in the memory 8, the pulses are output only from the selected output terminals and thereby a plurality of fluorescent discharge tubes may be lit simultaneously. Moreover, for example, it is possible to light simultaneously two discharge tubes and the tubes are actually lit in every other two tubes for every predetermined period. In this case, the function same. as the neon sign can be realized and further variety of lighting pattern can also be attained by changing the duty ratios of pulses output in every two tubes. As explained above, the lighting pattern can be obtained freely only by changing the data to be stored in the memory 8. Therefore, it can be said that the lighting apparatus of the present invention provides affluent generality.

Referring to FIG. 6, the waveforms are indicated at the principal points in such a case that the pulse of the pattern indicated in Fig. 4 is output from the output port 6.

As indicated in the same figure, when the switch 40 turns ON and the power is supplied from the AC power supply 1, the electronic stabilizer 2 and microcomputer 3 start operations. The electronic stabilizer 2 always outputs the high frequency voltage having the waveform indicated in Fig. 6(A). Meanwhile, the output port 6 sequentially outputs the pulses indicated in Fig. 6(B) sequentially outputs the pulses indicated in Fig. 6(B) from the output terminals P1 to P8. The voltages output from the electronic stabilizer 2 are applied to the fluorescent discharge tubes L1 to L8 as indicated in 6(C) and the tubes L1 to L8 light sequentially. However, as indicated in 6(C), since the fluorescent discharge tube shows the afterglow effect, the light flux is reduced as indicated by the dotted line and therefore a person always sees the two fluorescent discharge tubes as if these are lighting even in case of the microscopic viewpoint.

Referring to FIG. 7, there is indicated various circuit diagrams of the switching means. The circuit indicated in FIG. 7(A) uses a triac 60. The gate terminal of this triac is connected to the output terminal of output port 6 and both terminals which flow a load current are respectively connected to any of the load lines A1 to A8 and the common line C. This triac maintains the non-conductive condition when the pulse is applied to the gate terminal thereof and also maintains the conductive condition when the pulse is applied in order to apply the voltage to each fluorescent discharge tube from the electronic stabilizer 2.

The circuit of Fig. 7(B) is formed by the circuit combining the bridge-connected diodes 61, 62, 63, and 64, and thyristor 65. The gate terminal of thyristor 65 is connected to the output terminal of output port 6, the cathode terminal of the thyristor 65 to the earth terminal E and both terminals of bridge are connected respectively to the load lines A1 to A8 and common line C. When the pulse is applied to the

gate terminal, the thyristor maintains the conductive condition and a voltage is applied to each fluorescent discharge tube from the electronic stabilizer 2. When the pulse is not applied, the thyristor maintains the non-conductive condition.

The circuit of 7(C) is formed by the circuit combining the bridge-connected diode 66, 67, 68, and 69, and transistor 70. The base terminal of the transistor 70 is connected to the output terminal of output port 6, the emitter gate of the transistor 70 to the earth terminal E, and both terminals of the bridge respectively to the load lines A1 to A8 and common line C. When the pulse is applied to the base terminal, the transistor 70 becomes conductive and a voltage is applied to each fluorescent discharge tube from the electronic stabilizer 2, and when the pulse is not applied, the transistor maintains the non-conductive condition.

Finally, the circuit of FIG. 7(D) is a master slave circuit formed using a pair of thyristors S1 and S2. The gate terminal of thyristor S1 is connected to the output terminal of output port 6, the connecting point of the cathode terminal of thyristor S1 and the anode terminal of thyristor S2 to the common line C, the connecting point of the anode terminal of thyristor S1 and cathode terminal of thyristor S2 to the load lines A1 to A8, the cathode terminal and gate terminal of thyristor S2 respectively to the load lines B1 to B8 through the capacitor 71 or resistor 72 connecting the diode 73. When the pulse is input to the gate terminal of thyristor S1, a voltage is applied to each fluorescent discharge tube from the electronic stabilizer 2, this voltage is then applied to the gate terminal of thyristor S2 through the commutation, turning ON the thyristor S2 and turning OFF the thyristor S3. Thereby, the output of electronic stabilizer 2 can be applied to each fluorescent discharge tube.

Referring to FIG. 8, a control means is shown which is formed by a pulse generating circuit not using the microcomputer. As shown in this figure, the pulse generating circuit 3' as the control means comprises a power supply 4, an oscillator 50 which generates a pulse of predetermined oscillation frequency, a frequency divider 51 which divides frequency of pulse output from this oscillator 50 and a distribution circuit 52 which sequentially distributes the pulses output from this frequency divider 51 to the output terminals P1 to P8. Therefore, the pulse having predetermined duty ratio is sequentially or freely output from the selected output terminals. The other structure indicated in the same figure is the same as that shown in FIG. 2, and operations of the circuit in such a case where the pulse is output from the distribution circuit 52 are the same as those shown in the operation flowchart indicated in Fig. 3.

As explained above, this embodiment shows a circuit indicated in Fig. 2 and Fig. 8 as the concrete circuit of the electronic stabilizer 2. But, the present invention is not limited thereto and may be adopted to any type of circuit which has the structure of the known electronic stabilizer. Moreover, as the control means, the circuit formed by the microcomputer and that formed by the pulse generator comprising the frequency divider and pulse distribution circuit are indicated. The present invention can also be adopted to any type of circuit, other then the circuit described above, in case the circuit is formed to sequentially or freely output the pulse to the predetermined terminals. In addition, the circuit shown in Fig. 2 and Fig. 7 is indicated as the switching means but other type of circuit may also be employed in case the circuit flow a current to the fluorescent discharge tube only in the pulse receiving period.

In the embodiment of the present invention, the circuit lights total of eight fluorescent discharge tubes. But, it is of course possible for the structure to light a larger number of tubes within the scope where the lighting apparatus of the present invention operates stably and, moreover, the discharge tube is not limited only to the fluorescent discharge tube, and other types of discharge tubes may also be used.

As explained earlier, the lighting apparatus of the present invention is capable of obtaining every kind of lighting patterns by forming the lighting pattern program which is to be stored in the memory of microcomputer or the hardware structure of pulse generating circuit in such a way as satisfying the requirements and brightness of fluorescent discharge tube may be set individually within the predetermined range. What is more, since the fluorescent discharge tubes connected to the lighting apparatus light on the time sharing basis, the power consumption required for lighting can be saved by about 40% even in case all tubes connected to the lighting apparatus are lit, in comparison with the apparatus which is used currently in general, making much contribution to energy saving. Moreover, since a plurality of fluorescent discharge tubes may be lit only with one lighting apparatus, the lighting apparatus is not required for every tube, unlike the prior art. Accordingly, the weight as the lighting apparatus may be reduced and the space required for wiring may also be reduced.

As is obvious from above explanation, the present invention lights a plurality of discharge tubes with the lighting apparatus formed by a stabilizer which connects respectively the one end of a plurality of discharge tubes to the one end of output terminals, a plurality of switching means which respectively and individually connect the other ends of output terminals of the stabilizer to the other ends of the discharge tubes, and a control means which individually switches a plurality of switching means. Accordingly, it is possible to light a plurality of discharge tubes with only a single unit of lighting apparatus. Thus, weight and size can be reduced, and the wiring works can also be simplified. Moreover, since every kind of lighting pattern and brightness may also be set freely within the predetermined range, the lighting apparatus having affluent generality can be provided. In addition, the discharge tubes are lit on the time sharing basis even in case the discharge tubes connected to the lighting apparatus are all lit. Therefore the power consumption required for lighting can be saved in comparison with the lighting apparatus which is

used currently in the art, making a great contribution to energy saving.

Although the invention has been described in connection with specific embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art in the light of the foregoing description and drawings. Accordingly, it is intended to embrace all such alternatives, modifications and variations within the spirit and scope of the invention as defined by the appended claims.

Claims

1. A lighting apparatus comprising:

a stabilizer having a plurality of output terminals at one end, and a plurality of discharge tubes, each of said output terminals being connected at one end, respectively, to one end of one of said discharge tubes,

a plurality of switching means individually connecting the other ends of the output terminals of said stabilizer to respective other ends of said discharge tubes, and

control means arranged to switch said plurality of switching means individually.

2. A lighting apparatus according to Claim 1, wherein said stabilizer is an electronic stabilizer formed by electronic circuits.

3. A lighting apparatus according to Claim 1, wherein said switching means are formed by a circuit which operates by receiving pulses.

4. A lighting apparatus according to Claim 1, wherein said control means is formed by a microcomputer which is capable of freely setting the duty ratio of pulse output to individual switching means in accordance with a program and selecting the switching means to apply said pulse.

5. A lighting apparatus according to Claim 1, wherein said control means is formed by a circuit which outputs sequentially the pulse of predetermined duty ratio to the selected switching means.

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FIG.1

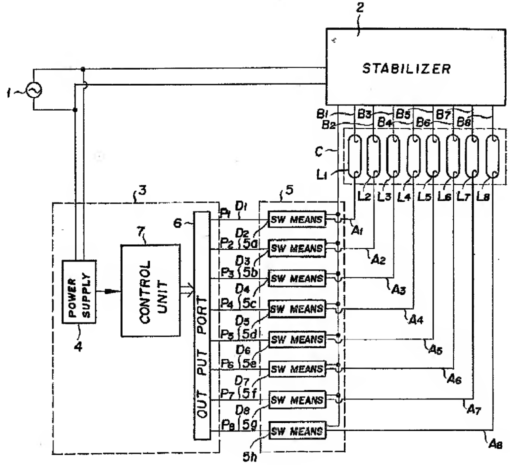

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FIG. 2

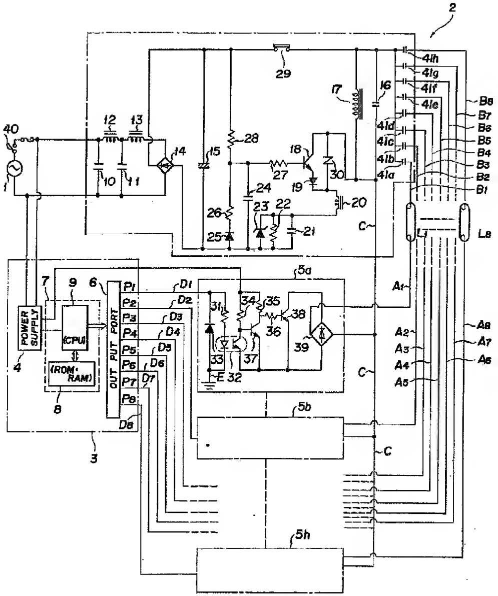

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FIG.3

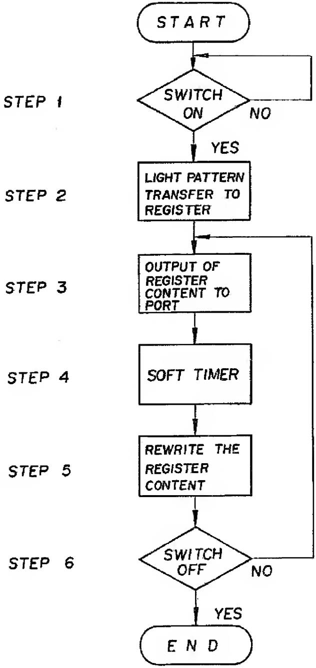


FIG.4

OUTPUT PORT NUMBER PULSE WAVEFORMS OF OUTPUT PORT

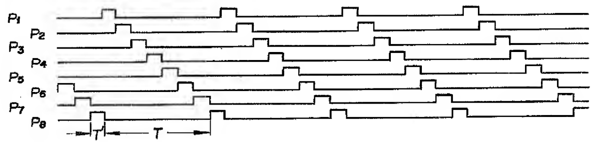


FIG.5

OUTPUT PORT NUMBER PULSE WAVEFORMS OF OUTPUT PORT

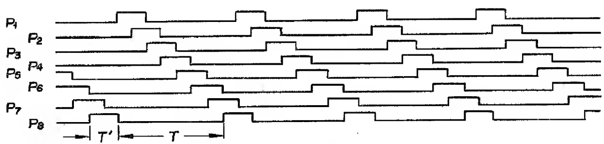


FIG.6A

FIG.6B

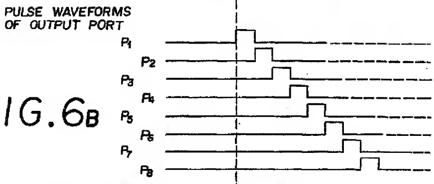
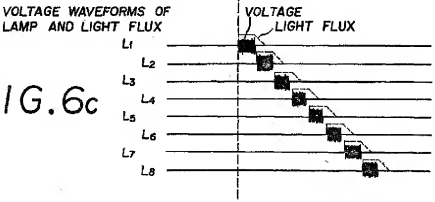


FIG.6C



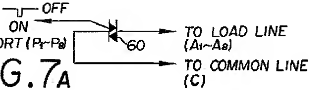


FIG. 7A

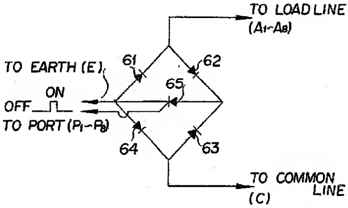


FIG. 7B

FIG. 7C

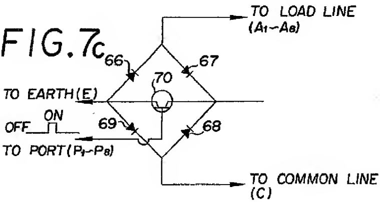


FIG. 7D

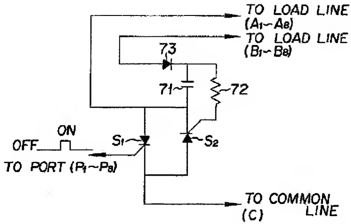
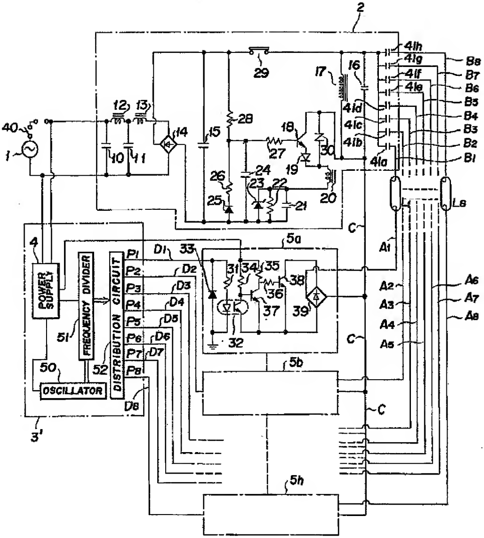


FIG.8



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OSCILLATOR
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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 85 0031

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	FR-A-1 483 350 (WIDMAYER) * Whole document * ---	1-4	H 05 B 37/02 H 05 B 41/392
A	US-A-4 189 663 (SCHMUTZER) * Column 4, line 20 - column 6, line 48; figure 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			H 05 B 37/00 H 05 B 41/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04-05-1988	DUCHEYNE R.C.L.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

T : theory or principle underlying the invention
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D : document cited in the application
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& : member of the same patent family, corresponding document